Space Weather Technical Forecast

Issued on Monday, 03 July 2023 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence slowly declining. R1/R2 Radio Blackouts likely. Chance of S1/Minor radiation storm on 03 July. Slight chance of G1/Minor Geomagnetic Storm on 04 Jul.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been High with an X1 flare peaking at 02/2314 UTC from AR3354 in the northwest. This remains the largest and most complex region on the visible disc. The region has grown slightly through the period, and is just about retaining a weak delta spot. AR3358 and AR3359 in the southeast have both either grown slightly, or revealed additional spots as they become more clearly visible. Both are showing signs of trying to develop delta spots, although neither has a clear signature at the present time. The remaining regions on the disc are relatively small and stable at this time.
Two M-flares from AR3359 at 01/2223 UTC and 02/0235 UTC appear to have resulted in separate, slow CMEs. These have been assessed as missing behind Earth in its orbit. We await coronagraph imagery to see if the X-flare has produced a CME.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, indicates a waning weak connection to CH18/+. The wind speed was mostly at slightly elevated levels between 400-500 km/s, but with a slight declining trend. The density was largely below average. The IMF was weak throughout, below 7 nT, while the north-south component varied weakly. The phi angle was positive (away from the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV) was at mainly high levels, peaking at 2200pfu at 02/1925 UTC. The 24-hour integrated fluence has been on a steady trend just above the Active threshold throughout. A fluence of 1.19e8 was recorded at 03/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is likely, with a slight chance of further X-class flares. The risk is mostly coming from AR3354 in the northwest, but potentially also from AR3358 and AR3359 in the southeast.

Solar Wind / Geomagnetic Activity: A CME associated with the M3.8 flare from AR3354 on 29 Jun may include an Earth-directed component. Any glancing arrival at Earth would be expected on 04 July, but it is considered more likely to miss. Current slightly elevated solar winds from the fast wind of CH18/+ are slowly declining and should become ambient during 03 July. Any connection to small CH20/- is expected to be weak. Wind speeds are expected to be ambient or slightly elevated throughout.
Geomagnetic activity is expected to be mostly Quiet, with only a slight chance of Active or G1/Minor Storm conditions on 04 July should we see any weak HSS or possible glancing CME impact.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a

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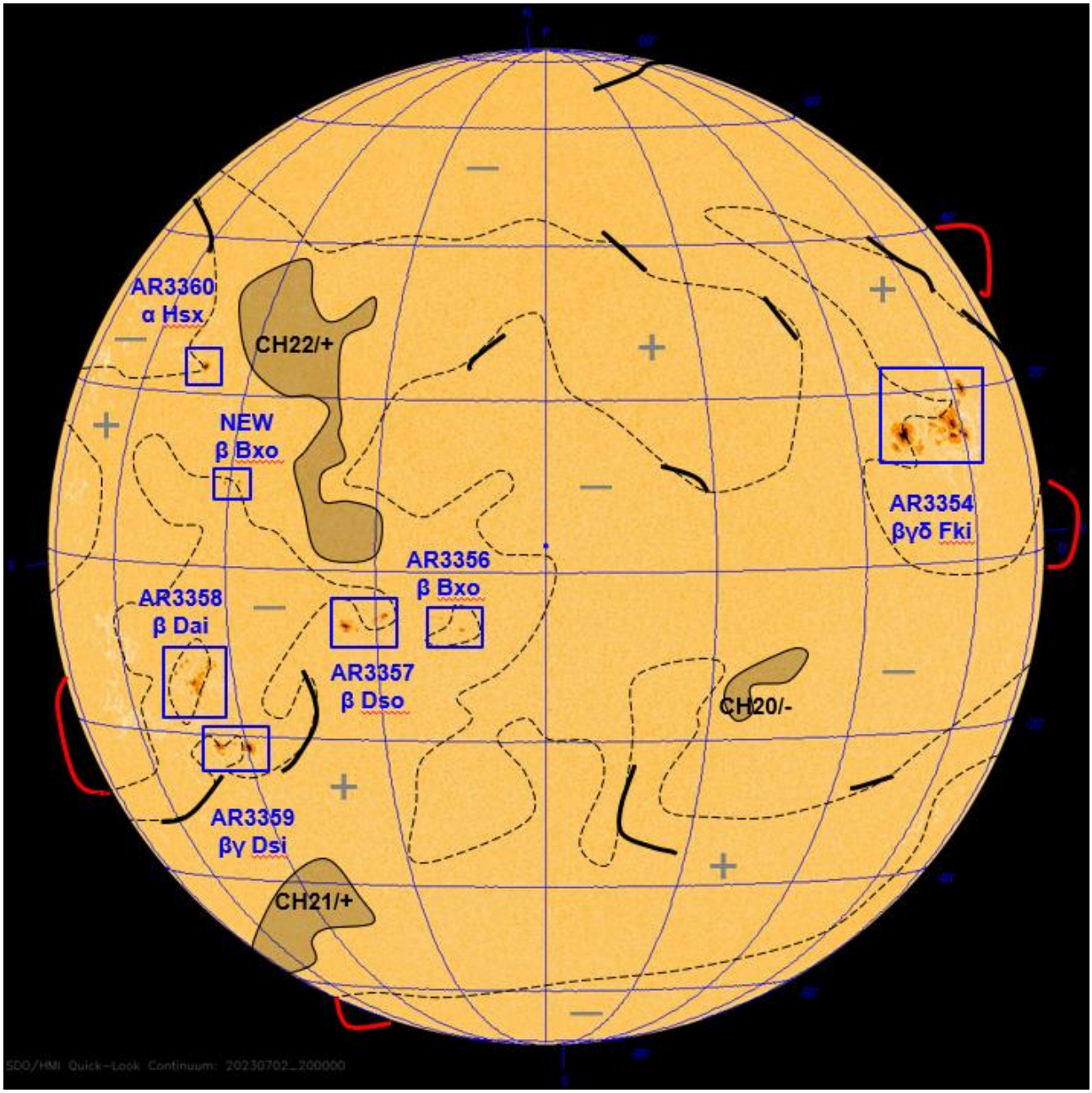
chance of reaching the S1/Minor Storm threshold on 03 July due to the recent X1 flare from AR3354. Should this event not give a radiation storm, then there is a slight chance of S1/Minor storm levels being reached through the rest of the period.
High energy electron flux (greater than 2MeV) is expected to remain at diurnally high levels in the coming days, with a gradual reduction through the period in the absence of any geomagnetic activity. The corresponding fluence is above the Active (1e8 integrated flux) threshold and also expected to slowly decline.

Figure 1. Solar Analysis Valid 02/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME associated with the M3.8 flare from AR3354 on 29 Jun may include an Earth-directed component, however most, if not all, of the ejecta appears directed above Earth. Any glancing arrival at Earth would be expected on 04 July, but it is considered more likely to miss.
Current slightly elevated solar winds from the fast wind of CH18/+ are slowly declining and should become ambient during 03 July. A connection to small CH20/- in the southwest may occur on 04 July, however any enhancements from this are expected to be weak. No further coronal hole HSS activity is forecast during this period, and wind speeds are expected to be ambient or slightly elevated throughout.

Geomagnetic activity is expected to be mostly Quiet, with only a slight chance of Active or G1/Minor Storm conditions on 04 July should we see any weak HSS or possible glancing CME impact.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/2131	Partial	Flare from AR3354	N Centre disc	762 km/s	04/0600 UTC	Glancing blow possible

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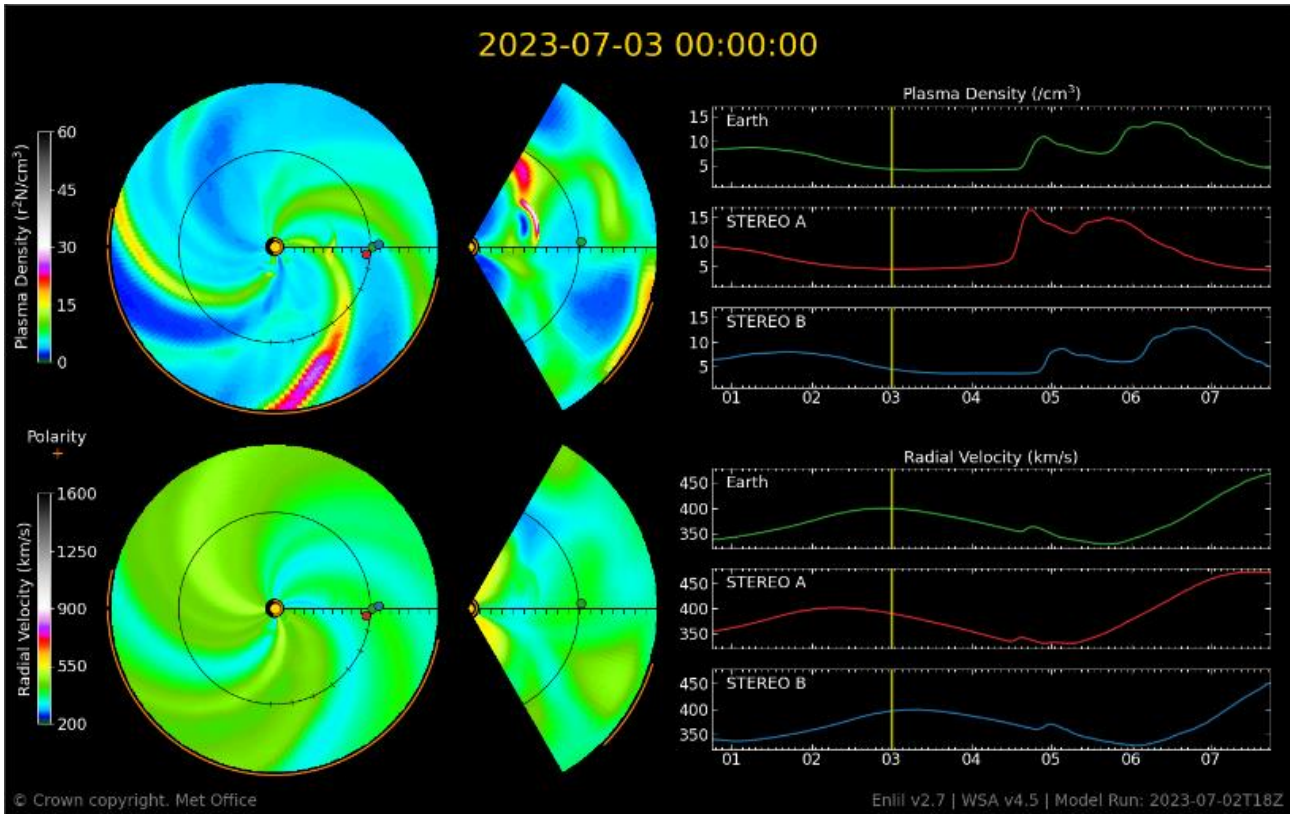
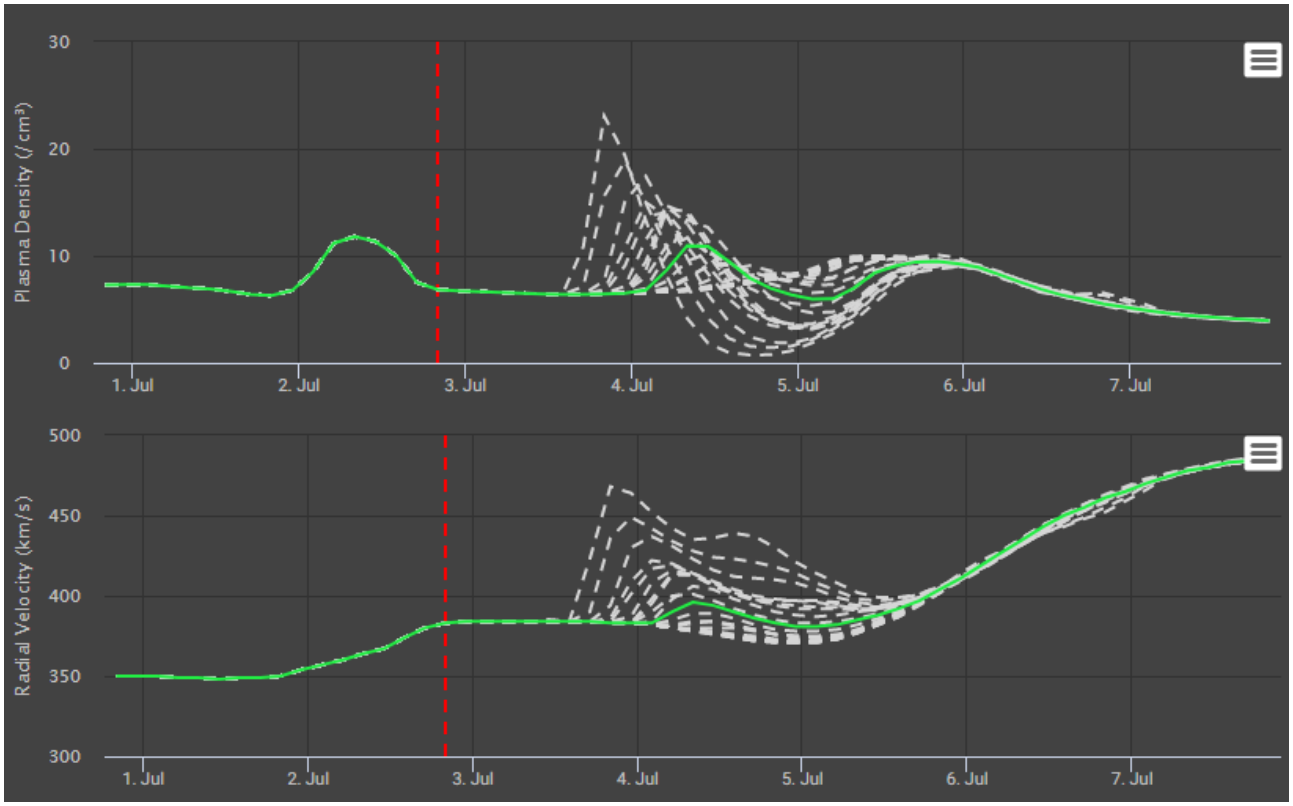
Figure 2: MOSWOC Enlil and ensemble, with a possible glancing CME blow on 04 July.





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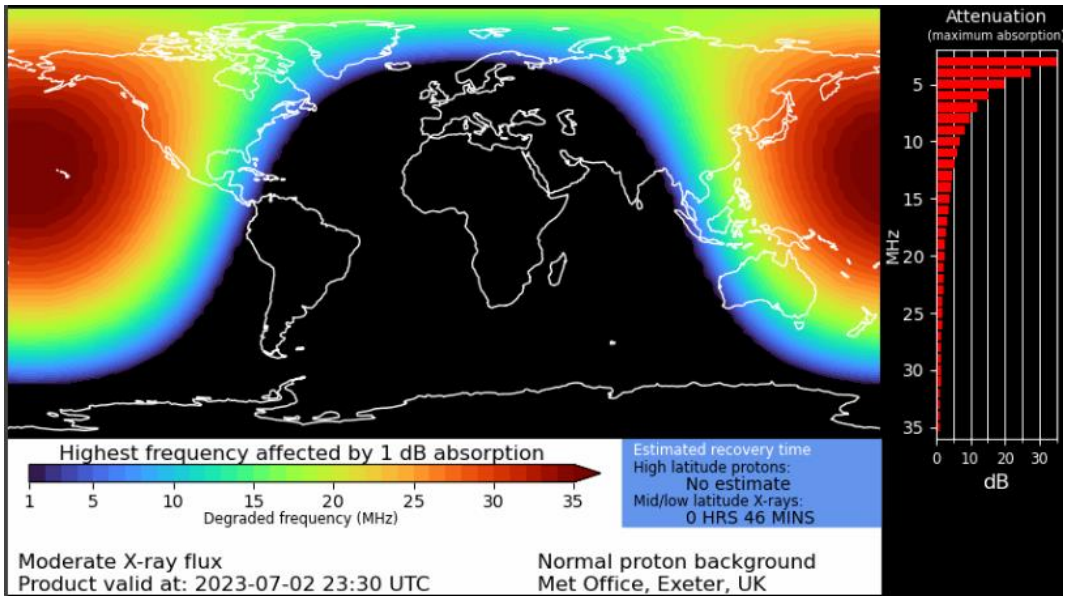
Radio Blackouts - X-Ray Flares:
Solar activity has been High with an X1 flare peaking at 02/2314 UTC from AR3354 in the northwest.

There are now seven sunspot regions on the visible disc, with AR3355 having faded. AR3354 in the northwest remains the largest and most complex region with a slight increase in overall size. A small and weak delta spot is still evident. AR3358 and AR3359 in the southeast have both either grown slightly, or revealed additional spots as they become more clearly visible. Both are showing signs of trying to develop delta spots, although neither has a clear signature at the present time. The remaining regions on the disc are relatively small and stable at this time.

Low to Moderate solar activity is expected with a slight chance of further isolated X-class flares. AR3354 rotates off the disc during 05 July, with a declining risk of flares during 05-06 July. As such the flare risk reduces during the period, but this may be revised should additional sunspots develop or active regions emerge over the east limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	40
Very Active	R3 to R5 X Class	Yes	15	15	10	5

Figure 3: MOSWOC DRAP showing radio blackout effects on the dayside of Earth, shortly after the X1 flare occurred.



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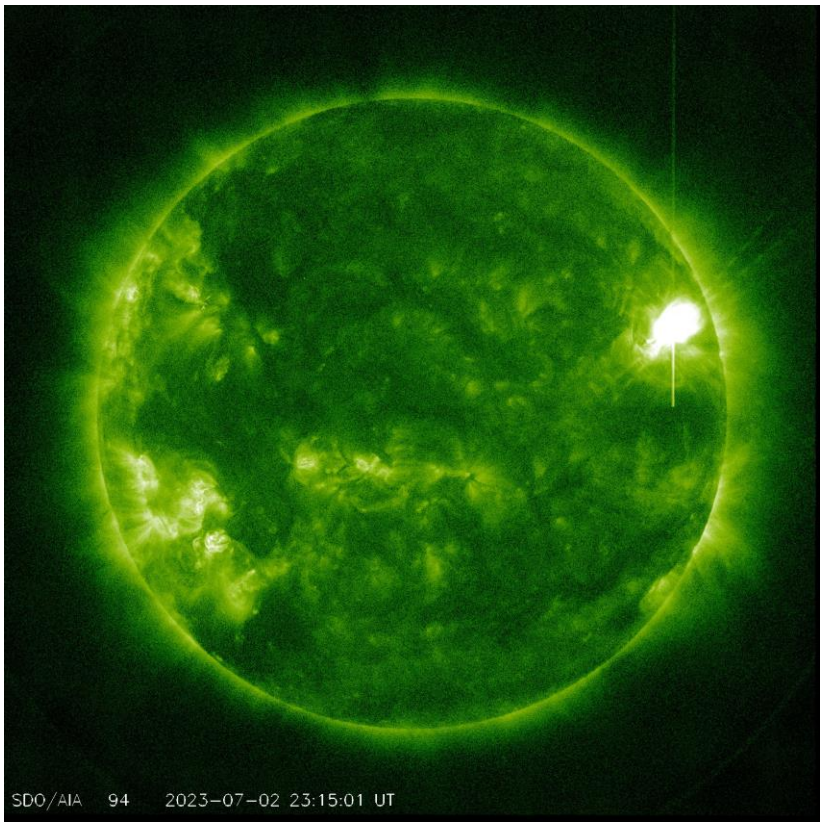
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. The raised probability of a proton event on 03 July is due to the recent X1 flare from AR3354, which is in a good location to give increased proton flux at Earth. Should this event not give a radiation storm, then there is a slight chance of S1/Minor storm levels being reached through the rest of the period. This is mainly due to AR3354, given its favourable location in the western hemisphere. Although AR3354 rotates off during 05 July, the risk of radiation storms remains until it is well over the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	40	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO AIA-094 imagery showing the X1 flare from AR3354. This is in a good location to cause an increase in proton flux at Earth, and we are waiting to see if a proton response will occur.



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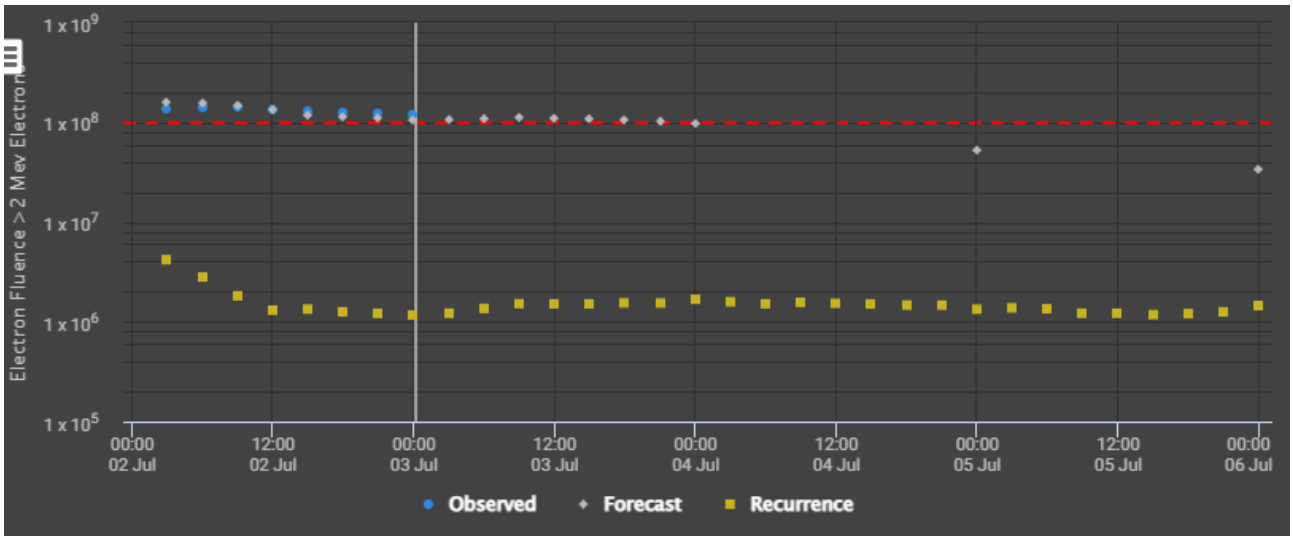
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is currently high and likely to continue to peak at high levels through this period in the absence of any notable geomagnetic activity. There is a slight chance of a CME arrival or weak HSS on 04 July which could give a sharper decrease in flux levels, but these features are low confidence and it is more likely that there will be little effect from them. It is considered most likely that there will be a gradual decline in flux levels at GEO through the period, although with some uncertainty in the overall values.

Electron fluence is expected to start above the Active threshold, probably with a slow decline, although confidence is low in the exact timing of any decrease below Active. MOSWOC REFM is also suggesting a slow decline below Active, which is a reasonable trend.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	50	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM showing fluence just above the Active threshold, with a slow decline forecast.



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